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Adaptive Memory: Survival Processing Increases Both True and False Memory in Adults and Children

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Research has shown that processing information in a survival context can enhance the information's memorability. The current study examined whether survival processing can also decrease the susceptibility to false memories and whether the survival advantage can be found in children. In Experiment 1, adults rated semantically related words in a survival, moving, or pleasantness scenario. Even though the survival advantage was demonstrated for true recall, there also was an unexpected increase in false memories in the survival condition. Similarly, younger and older children in Experiment 2 displayed superior true recall but also higher rates of false memories in a survival condition. Experiment 3 showed that in adults false memories were also more likely to occur in the survival condition when categorized lists instead of Deese-Roediger-McDermott (DRM)-like word lists were used. In all three experiments, no survival recall advantage was found when net accuracy scores that take the total output into account were used. These findings question whether survival processing is an adaptive memory strategy per se, as such processing not only enriches true recall but simultaneously amplifies the vulnerability to false memories.

Keywords: adaptive memory, DRM, false memories, development

Recent studies suggest that memory evolved to promote the processing of survival-relevant information (e.g., Nairne, Pandeirada, Gregory, & Van Arsdall, 2009; Nairne, Thompson, & Pandeirada, 2007; Weinstein, Bugg, & Roediger, 2008; see also Nairne & Pandeirada, 2008b). A recurrent finding is that processing information according to its fitness value yields superior retention compared with processing information in other contexts (e.g., moving, pleasantness, personal relevance). In Nairne et al.'s (2007) initial study, participants had to imagine being in a survival situation deprived of any basic needs and in danger of predators. Then, they were presented with words that had to be rated for the relevance of the situation. Afterward, they received a surprise free recall test. Nairne and colleagues (2007) found that encoding words for their survival relevance benefits memory significantly more than encoding words in control conditions (e.g., moving, pleasantness, personal relevance).

This survival recall advantage has been replicated with numerous control conditions intended to match the survival context in terms of novelty, arousal, and media exposure (Kang, McDermott, & Cohen, 2008), schematic processing (Weinstein et al., 2008), and ancestral priorities (Nairne et al., 2009). Moreover, as it was recently shown that this effect also occurs when pictures are used (Otgaar, Smeets, & van Bergen, 2010), the survival effect appears to be unaffected by stimulus presentation modality. Collectively, these studies suggest that the survival recall advantage is a robust and universal phenomenon.

However, although the aforementioned findings are encouraging, previous research on adaptive memory has concentrated almost exclusively on information that was *correctly* remembered by *adults*. Whether processing fitness-relevant information can also decrease the susceptibility to memory distortions and whether these adaptive memory processes are innate or the result of developmental trends remains open to empirical testing. Hence, the purpose of the current study was twofold. First, we were interested in whether survival processing would also affect adults' vulnerability to false memories. Second, we wanted to examine whether this superior survival recall is developmentally invariant by testing a sample of 8- and 11-year-old children. We now turn to the relevance of these issues.

If natural selection "tuned" memory to remember fitness-relevant information, then this would imply that survival processing prioritizes true recollection but also reduces the risk of false memories. Yet on the other hand, in two studies (Nairne et al., 2007, Experiment 1; Nairne & Pandeirada, 2008a, Experiment 1), higher intrusion rates were found in the survival condition than in the pleasantness condition. In addition, we recently found elevated levels of memory distortions in a survival-processing condition compared with a pleasantness-rating condition, but the amount of distortions did not differ between the survival and moving scenario (Otgaar et al., 2010, Experiment 1). This finding suggests that survival processing may be counterproductive and might even contribute to the formation of false memories. In contrast to previous studies on adaptive memory, the present study was spe-

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cifically designed to investigate the effect of survival processing on false memories. To be precise, we used semantically related words adopted from the Deese-Roediger-McDermott paradigm (DRM; Deese, 1959; Roediger & McDermott, 1995), a paradigm known to reliably induce false memories in adults and children (e.g., Brainerd, Reyna, & Ceci, 2008; Howe, Wimmer, Gagnon, & Plumpton, 2009; Sugrue & Hayne, 2006). To examine whether adaptive memory processes are also present at young ages, we tested the survival recall advantage in younger and older children. Even though younger children remember less (both correctly and incorrectly) than do older children and adults (e.g., Otgaar, Candel, Merckelbach, & Wade, 2009; Sugrue & Hayne, 2006; Sutherland & Hayne, 2001), enhanced memory for fitness-relevant information was also expected to be present in younger and older children. Also, as the current study concentrated on adults' and younger and older children's true and false recall, we had the opportunity to examine whether survival processing also yields superior *net accuracy* scores than other processing modes (see Brainerd et al., 2008).

In Experiment 1, adult participants were randomly assigned to a survival, moving, or pleasantness condition. Next, they were presented with semantically related words, and they were asked to indicate the relevance of those words for the scenario. Then, they received a surprise recall test. We hypothesized that participants in the survival condition would correctly recall more words than participants in the control conditions (i.e., moving, pleasantness) and that survival processing would result in lower false memory rates.

In Experiment 2, 8- and 11-year-old children underwent a procedure similar to the one used in Experiment 1. We predicted that younger and older children in the survival condition would show a survival recall advantage in terms of true recall as well as being less susceptible to the false memory illusion than would children in the control conditions.

To examine whether survival processing would also affect false memories when stimuli other than DRM lists are used, we conducted Experiment 3. Here, adult participants were allocated to a survival or pleasantness condition and were presented with categorized material. In terms of net accuracy, we expected all experiments to show that survival processing would produce higher accuracy rates than would control conditions.

Experiment 1

Method

Participants. Sixty-nine undergraduate students (M_{age} = 21.94 years, $SD = 3.48$; 19 men) participated in this experiment. They received a small compensation for their involvement (€5). They were tested individually in separate rooms at the university. Sessions lasted for approximately 30 min. The study was approved by the standing ethical committee of the Faculty of Psychology and Neuroscience, Maastricht University.

Materials: DRM lists. Participants were presented with six lists of 10 words each (see Appendix A). These words were semantically related (e.g., *baker, flour, dough*), and all converged on a nonpresented word (i.e., critical lure: *bread*). List words were selected from the Dutch word association norms (Van Loon-Vervoorn & Van Bekkum, 1991). With the Celex lexical database (Centre for Lexical Information, 1995) and Dutch word association norms, critical lures did not differ in terms of word frequency or backward associative strength.

Design and procedure. A between-subjects design with condition (survival, moving, and pleasantness) as the independent variable was used. Participants were randomly allocated to the survival (n = 24), moving (n = 24), or pleasantness (n = 21) condition. Specifically, they received a Dutch version of one of the following instructions:

Survival. "In this task, we would like you to imagine that you are stranded in the grasslands of a foreign land, without any basic materials. Over the next few months, you'll need to find steady supplies of food and water and protect yourself from predators. We are going to show you some words, and we would like you to rate how relevant each word would be in this survival condition. Some of the words may be relevant and others not—it's up to you to decide."

Moving. "In this task, we would like you to imagine that you are planning to move to a foreign land with your parents.[1] Over the next few months, you'll need to make new friends and learn a new language. We are going to show you some words, and we would like you to rate how relevant each word would be in this moving condition. Some of the words may be relevant and others not—it's up to you to decide."

Pleasantness. "In this task, we are going to show you some words, and we would like you to rate the pleasantness of each word. Some of the words may be pleasant and others may not—it's up to you to decide."

Next, the participants were instructed to rate the words according to the scenario they had just read. Words were presented on a computer screen for 5 s each. All word lists were presented in the same random order. Two practice words were included to ensure that participants understood the procedure. Participants had to rate the words on a 7-point rating scale (1 = *totally irrelevant or unpleasant,* 7 = *totally relevant or pleasant*). Participants had to make their responses on a scoring sheet. Also, they were informed that they had to respond within a 5-s interval. No mention was made of an upcoming recall task. After the rating task, participants had to perform a 2-min distractor task (the game Tetris). Next, they were subjected to a surprise free recall task in which they were instructed to write down all the words they had seen during the rating task. The recall task lasted approximately 10 min.

Results and Discussion

True recall. One-way analysis of variance (ANOVA) was used to examine the effect of condition on the dependent variables. Pairwise comparisons were performed with Tukey's honestly significant difference (HSD) tests. Figure 1 presents the mean proportion true recall per condition. Results revealed a significant main effect of condition, $F(2, 66) = 7.51$, $p < .001$, $\eta_p^2 = .19$, with the survival group outperforming the other two groups (both ps <

[1] We changed some sentences in the moving instruction. Specifically, we asked students and children to imagine that they were planning to move to a new house in a foreign land *with their parents* and that *they had to make new friends and learn a new language*. We did this because the original instruction was not suitable for children. For reasons of comparability, we gave these new instructions to both students and children.

.05). There was no significant difference between the moving and pleasantness conditions.

False recall. The mean proportion false recall is also shown in Figure 1. A significant main effect of condition was found, $F(2, 66) = 4.81$, $p < .05$, $\eta_p^2 = .13$, qualified by higher false memory rates in the survival group relative to the other two groups (both ps $< .05$). The pairwise comparison between the moving and pleasantness groups did not reach statistical significance. When we performed the same analysis on the total intrusion data (recall critical lures + extralist intrusions), we found a marginally significant main effect of condition ($p = .07$), with the survival condition ($M = 2.67$, $SD = 1.69$) having more total intrusions than the other two groups (moving: $M = 1.88$, $SD = 2.46$; pleasantness: $M = 1.38$, $SD = 1.07$).

Rating data. To examine whether the three conditions differed with respect to their ratings, we conducted an ANOVA on the rating data. A significant main effect of condition was detected, $F(2, 66) = 3.70$, $p < .05$, $\eta_p^2 = .10$, with participants in the pleasantness condition providing higher ratings than those in the survival condition ($p < .05$). The other pairwise comparisons were not significant. To test whether the rating data affected our survival recall advantage, we conducted an analysis of covariance (ANCOVA) with rating as covariate. Results demonstrated that the ratings did not influence the survival recall advantage. We also performed an ANCOVA with rating as covariate on the false recall. Like true recall, this analysis showed that the ratings did not affect the false memory rates ($p > .05$).

Net accuracy. To examine whether adults' adaptive memories were more accurate than other memories, we computed net accuracy scores defined as the ratio of true recall to true recall plus false recall (see Brainerd et al., 2008). It is interesting that we found no significant main effect of condition, $F(2, 66) = 1.84$, *ns*. Thus, no survival recall advantage was obtained when we looked at the net accuracy scores (see Figure 2).

In summary, Experiment 1 revealed two primary findings. First of all, in accordance with previous studies on adaptive memory (e.g., Nairne & Pandeirada, 2008a; Nairne, Pandeirada, & Thompson, 2008; Weinstein et al., 2008), the standard survival recall advantage was obtained for semantically related word lists. However, as this was accompanied by higher false recall rates, the net accuracy ultimately did not differ between the conditions. Clearly, this finding is difficult to reconcile with the view that memory is "tuned" to process information relevant for survival.

Figure 1. Adults' mean proportion true and false recall as a function of condition, Experiment 1.

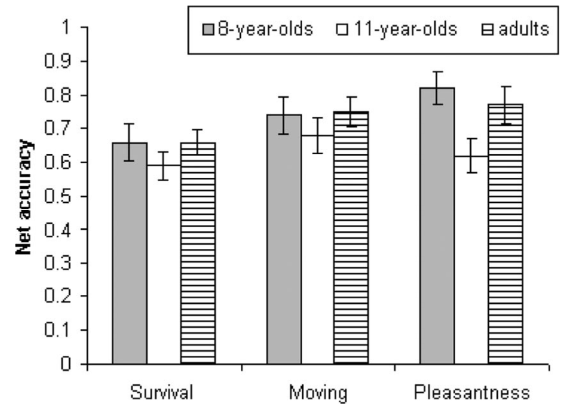

Figure 2. Mean net accuracy scores as a function of condition, by age group.

Experiment 2

From an adaptive memory perspective, one could expect to find evidence of survival processing in younger and older children. Thus, our aim in Experiment 2 was to replicate and extend the findings from Experiment 1 in a sample of 8- and 11-year-old children. The children in Experiment 2 underwent a procedure similar to the one used in Experiment 1.

Method

Participants. Children ($N = 170$) from two different age groups participated in this experiment (8-year-olds [*younger group*], $n = 99$, $M_{age} = 8.11$ years, $SD = 0.86$; 11-year-olds [*older group*], $n = 71$, $M_{age} = 11.37$ years, $SD = 0.49$). They were recruited from elementary schools in the Netherlands. Both the schools and children's parents assented to the children's participation. Children received a small present in return for their participation.

Materials. The same DRM word lists were used as in Experiment 1.

Design and procedure. A 2 (age: younger vs. older children) × 3 (condition: survival, moving, and pleasantness) between-subjects design was used. All of the children were randomly assigned to one of three conditions and received the same instructions as in Experiment 1.[2] Words were displayed for 6 s each, and all word lists were presented in the same random order. The children received two practice words before the rating task started. They rated the words on 7-point Smiley-scales (smallest smiley face = *totally irrelevant/unpleasant*, largest smiley face = *totally relevant/pleasant*). The children made their ratings on a scoring sheet and did not know that a later recall task was part of

[2] One may wonder whether children are able to understand and follow the original instructions of Nairne and colleagues (2007). To address this issue, we conducted a pilot study with five 8-year-olds and five 11-year-olds in which the children received the same instructions as in Experiment 2. After the recall test, we asked them if they could explain what exactly they did during the test. All of the children correctly reported what they had to imagine.

the experiment. After the rating task, the children played the videogame Tetris for 2 min, after which they were asked to recall all the words they could remember. Their responses were written down by the experimenter. The recall task lasted approximately 10 min.

Results and Discussion

True recall. A significant Age × Condition interaction was found for true recall, $F(2, 164) = 4.92$, $p < .01$, $\eta_p^2 = .06$ (see Figure 3). Simple effects showed that both the 8- and 11-year-olds demonstrated the survival recall advantage, with more words being recollected in the survival condition than in the other two conditions: younger children, $F(2, 95) = 5.44$, $p < .01$, $\eta_p^2 = .10$; older children, $F(2, 69) = 15.47$, $p < .001$, $\eta_p^2 = .31$. However, whereas in the younger children the moving and pleasantness group did not differ significantly from each other, the older children recalled significantly more words in the moving condition than the older children in the pleasantness condition ($p = .04$).

False recall. With regard to susceptibility to false memories, we found a significant main effect of condition, $F(2, 164) = 11.63$, $p < .001$, $\eta_p^2 = .12$ (also see Figure 3). Post hoc analyses with Tukey's HSD showed that in both age groups false recall was significantly higher in the survival condition than in the moving and pleasantness conditions (both ps $< .01$). The moving and pleasantness groups did not differ from each other. The ANOVA also revealed a significant age effect, $F(1, 163) = 26.34$, $p < .001$, $\eta_p^2 = .14$, with the older group being more susceptible to falsely recalling information than the younger group. No significant interaction between age and condition emerged. When we analyzed the total intrusion rate (recall critical lures + extralist intrusions), we found a significant Age × Condition interaction, $F(2, 164) = 4.37$, $p < .05$, $\eta_p^2 = .05$. Simple effect analysis showed that for the older children only, total intrusion rates were higher in the survival condition than in the other two conditions, $F(2, 68) = 9.69$, $p < .001$, $\eta_p^2 = .22$.

Rating data. An ANOVA was also carried out on the rating data so that we could examine whether the various groups differed in their ratings. A significant main effect of condition emerged, $F(2, 164) = 5.35$, $p < .01$, $\eta_p^2 = .06$, but no other main or interactive effects were found. The main effect of condition was qualified by younger and older children in the pleasantness condition, providing higher ratings than younger and older children in the survival condition ($p < .05$). An ANCOVA with the rating as covariate was conducted on true and false recall to investigate whether the rating data affected our recall findings. Both analyses showed that the covariate did not influence the recall data (ps $> .05$).

Net accuracy. When we analyzed children's accuracy scores (see Figure 2), we found a significant main effect of age, $F(1, 164) = 6.21$, $p < .05$, $\eta_p^2 = .04$, with younger children ($M = 0.74$, $SD = 0.30$) achieving higher net accuracy levels than older children ($M = 0.63$, $SD = 0.24$). More important, we did not find a significant effect of condition, $F(2, 164) = 2.00$, *ns,* suggesting that there was no net advantage associated with survival processing.

Comparison of adults and children. Relative comparisons between the patterns of results of Experiments 1 and 2 show that with regard to true recall, all groups demonstrated the standard survival recall advantage. Furthermore, as can been in Figures 1 and 3, in all age groups, false memory rates were higher in the survival group than in the other two control conditions. It is important that no survival recall advantage was shown when we examined children's and adults' net accuracy levels (see Figure 2).

In summary, Experiment 2 showed that processing information according to a survival scenario also advantages true recall in younger and older children. Thus, these data suggest that the mnemonic benefits of survival processing are already apparent in early childhood. Yet, we also showed that younger and older children produced higher false recall rates when processing information in a survival scenario, with older children being more susceptible to false recall than younger children. This latter finding is well in line with a host of studies showing an age-related increase in the DRM illusion (e.g., Brainerd & Reyna, 2002; Sugrue & Hayne, 2006; for a review, see Brainerd et al., 2008). Crucially, the current data show that there is no survival recall advantage in the ratio of true recall to true recall plus false recall (i.e., net accuracy). Obviously, to some extent these findings are at variance with the adaptive memory perspective of survival processing.

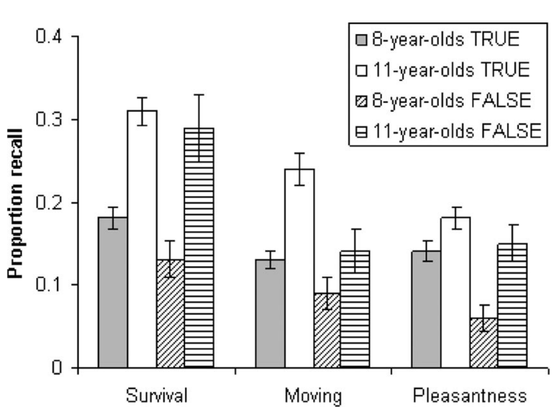

Figure 3. Eight- and 11-year-old children's mean proportion true and false recall as a function of condition, Experiment 2.

Experiment 3

The findings reported in Experiments 1 and 2 consistently showed that adults' and children's true and false memory rates are elevated when information is processed according to its fitness relevance. However, in both experiments, DRM lists were used to elicit adults' and children's false memories. One could of course argue that using these lists is biased against a survival recall effect, as these lists are specifically constructed to elicit high rates of false memories. To address this issue, in Experiment 3 we examined whether the susceptibility of adaptive memory to the false memory illusion also occurs when categorized materials are used (see Nairne & Pandeirada, 2008a). Thus, the purpose of Experiment 3 was to examine whether participants would report more intrusions in the survival condition than in the pleasantness condition when they had to process categorized material.

Method

Participants. Thirty-nine undergraduate students ($M_{age} = 21.03$ years, $SD = 2.78$; 14 men) were enrolled in this experiment. They received a small financial compensation for their involvement. They were tested individually in separate rooms at the university. Sessions lasted for approximately 30 min.

Materials: Categorized lists. Stimulus materials were selected from the Dutch norms for categories and exemplars (Ruts et al., 2004). Participants were presented with six categorized lists of 10 words each (see Appendix B). These words were categorically related (e.g., *violin, piano*), and all converged on a nonpresented word (i.e., exemplar: *guitar*).

Design and procedure. Participants were randomly assigned to a survival (n = 19) or pleasantness (n = 20) condition. They underwent the exact same procedure as in Experiment 1.

Results and Discussion

True recall. We found a significant main effect of condition, $F(1, 37) = 9.17$, $p < .01$, $\eta_p^2 = .20$, with the survival group recollecting more words than the pleasantness group (see Figure 4).

False recall. For false recall, we found that more false memories were elicited when the categorized words were processed for their fitness value than for their pleasantness, $F(1, 37) = 6.04$, $p < .05$, $\eta_p^2 = .12$ (see Figure 4). When we looked at the total intrusions (recall exemplar + recall extralist intrusions), we found that more intrusions were reported in the survival group ($M = 0.32$, $SD = 0.48$) than in the pleasantness group ($M = 0.10$, $SD = 0.31$). This difference was, however, not significant ($p = .10$).

Rating data. Higher ratings were found for the participants who received the pleasantness instruction ($M = 4.03$, $SD = 0.64$) compared with participants in the survival group ($M = 2.97$, $SD = 0.90$), $F(1, 37) = 18.18$, $p < .001$, $\eta_p^2 = .33$. When the rating data were included as a covariate, results showed that the survival recall effect persisted ($p < .05$). Furthermore, we found that the rating data did not affect the amount of false memories ($p > .05$).

Net accuracy. As to net accuracy scores, our results showed a significant main effect of condition, $F(1, 37) = 4.05$, $p = .05$, $\eta_p^2 = .10$, with the pleasantness group having higher net accuracy scores than the survival group (see Figure 5).

The findings of Experiment 3 agree well with what we found in Experiments 1 and 2. Specifically, Experiment 3 showed that the standard survival recall effect occurred but at the same time boosted false memory development, even when categorized material was used. Furthermore, as in Experiments 1 and 2, when we looked at the net accuracy scores, no survival recall effect was present, thereby providing additional evidence against the alleged adaptive value of survival processing.

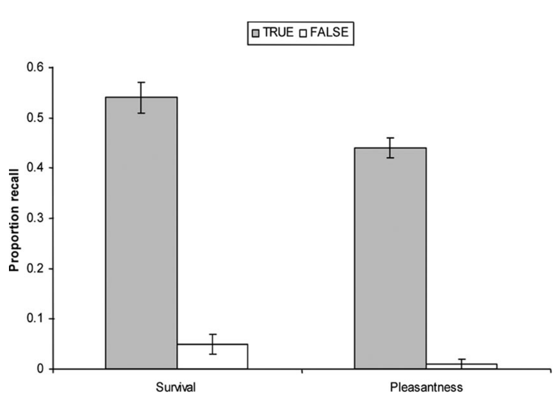

Figure 4. Adults' mean proportion true and false recall as a function of condition, Experiment 3.

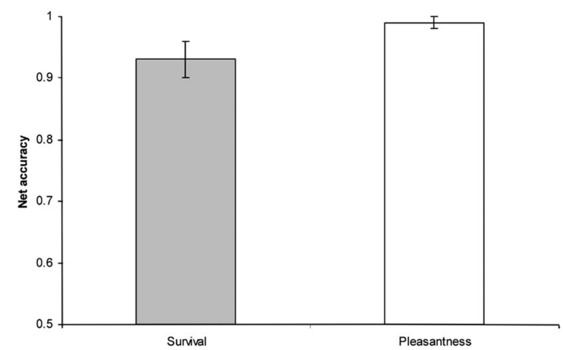

Figure 5. Mean net accuracy scores as a function of condition, Experiment 3.

General Discussion

The aim of the current study was to examine whether survival processing affects the development of children's and adults' false memories and whether the survival recall advantage also occurs in a child sample. We found that adults (Experiments 1 and 3) *and* children (Experiment 2) displayed a survival recall advantage for true recall but, in addition, more readily falsely recalled nonpresented information in a survival context. Thus, the survival recall advantage disappears when one looks at net accuracy scores that take the total output into account. Both findings (i.e., heightened false recall following survival processing and no recall advantage in terms of net accuracy) challenge the view that survival processing is an adaptive memory strategy.

The current findings may also bear relevance to the understanding of the development of false memories. That is, the fact that both children's and adults' true and false recall rates increased under survival processing conditions is in line with models that rely on spreading activation across related items in memory networks (e.g., activation-monitoring theory, see Roediger, Balota, & Watson, 2001; associative-activation theory, see Howe, Wimmer, Gagnon, & Plumpton, 2009). In both models, often what increases true recall (spreading activation throughout integrated networks) also increases false recall because this spread extends to nonpresented, though related, items. The fact that we found these similar increases in both true and false recall can also be explained well with fuzzy-trace theory (FTT; Brainerd et al., 2008). According to FTT, true recall is primarily sustained by verbatim traces, whereas false recall arises due to reconstructive processes inherent in gist traces. Furthermore, FTT predicts that any manipulation that increases gist memory processes will enhance both true and false memory rates. Apparently then, survival processing causes participants to rely more heavily on gist processing, which in turn may have affected both true and false memory levels. Apart from which theory offers the most convincing and parsimonious explanation, the current experiments have produced a series of consistent and novel findings regarding children's and adults' adaptive memory and false memory development.

The present study is the first to show enhanced true recall following survival processing in a sample of young children. Showing that adaptive memory benefits evidently already sprout in childhood and remain present in adulthood extends previous research on adaptive memory (e.g., Nairne et al., 2008; Weinstein et al., 2008). Of importance, these results seemingly indicate that the survival advantage for true recall is a robust phenomenon in that it can be elicited not only when different control conditions (Kang et al., 2008; Nairne et al., 2009; Weinstein et al., 2008) and stimuli (Otgaar et al., 2010) are used but also when various age groups (i.e., children and adults) are involved.

We also found that survival processing boosted the susceptibility to false memory development for word lists that are *not* specifically developed to trigger false memories (i.e., categorized lists; Experiment 3). Although Nairne and Pandeirada (2008a) also used categorized lists, they did not find that false memories were more likely to be elicited when words were processed for their survival importance. Here, we showed that overall false memory rates were lower when information was processed using categorized lists rather than DRM lists. This is not surprising as the connectivity between list items and their lures differs between categorized and DRM lists. That is, categorized lists possess a vertical or superordinate structure, whereas DRM items and their critical lures are horizontally related to each other. Research shows that lists that have a horizontal structure (i.e., DRM lists) are more likely to trigger false memories than are vertically related lists (see Howe, Wimmer, & Blease, 2009). Thus, it seems that the susceptibility of adaptive memory to false memories is not restricted purely to DRM lists but also extends to other materials, such as categorized word lists.

Our finding that the survival recall effect apparently disappears when net accuracy scores are considered raises some debatable issues for the adaptive memory view. Particularly, if memory truly evolved to process fitness-relevant information, then the survival recall effect would also occur in terms of net accuracy—for example, by decreasing or at least not affecting false recall rates. The present data clearly show otherwise and thus challenge the adaptiveness of survival processing. After all, from an adaptive memory view it would not appear to be adaptive for survival processing to increase the susceptibility to memory errors (e.g., false recall). However, it must also be acknowledged that false memories are not necessarily maladaptive by themselves, but that they are a side-effect of something that *is* very adaptive. So, processing information according to its fitness value may activate related information in memory, which then might be used to draw attention to other survival-related materials. This extremely fast automatic activation of related information in memory might, thus, still be viewed as adaptive, as it would allow people to scan the environment for stimuli relevant for survival-related situations (see Howe & Derbish, 2010).

One could also speculate that false memories are adaptive because “misremembering” details might be beneficial in particular situations (e.g., Sutton, 2009). For example, imagine that someone is in a potentially perilous location in which there are indications of a predator being nearby (e.g., fresh animal tracks). The person who “misremembers” seeing a predator is more likely to survive because he or she will be less likely to visit that specific location in future times.[3] Although the aforementioned explanations are intuitively appealing, the two main findings of the current study (i.e., increased false recall and no advantage in terms of net accuracy following survival processing) more likely indicate that the survival recall effect is sensitive to certain boundary conditions. Obviously, future studies should further examine the precise conditions under which the survival recall effect occurs.

In summary, the present experiments are the first showing that (a) both true and false recall are amplified by survival processing in adults and children, and (b) the survival recall advantage thus appears to occur only when true recall is considered and disappears when net accuracy scores are calculated. Collectively, these data question whether processing information according to its fitness value is an adaptive strategy per se or whether this type of processing comes at the cost of an increased vulnerability to false memories.

[3] We thank James Nairne for bringing this to our attention.

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Appendix A

Examples of the Six Word Lists and Their Critical Lures (in Italics) Used in Experiments 1 and 2 (English Translation)

Bread	*Pain*	*Cry*	*Window*	*Dead*	*Sweet*
Baker	Ouch	Tears	Frame	Alive	Sour
Butter	Ache	Sorrow	Glass	Coffin	Sugar
Filling	Fear	Laugh	Door	Corpse	Candy
Brown	Stomach	Whine	Casement	Grave	Bitter
Dough	Head	Baby	Curtain	Bury	Good
Grain	Unpleasant	Scream	Windowpane	Black	Honey
Flour	Horrible	Roar	Open	Pale	Child
Knife	Shooting	Whining	House	Skeleton	Quiet
Wheat	Bed	Wet	Look	Funeral	Bad
Old	Doctor	Weep	View	Cemetery	Salt

Appendix B

Examples of the Six Categorized Word Lists and Their Exemplars (in Italics) Used in Experiment 3 (English Translation)

Dog	*Car*	*Soccer*	*Fly*	*Apple*	*Guitar*
Cat	Bike	Tennis	Mosquito	Pear	Piano
Horse	Bus	Swimming	Ant	Banana	Violin
Cow	Train	Volleyball	Bee	Orange	Flute
Elephant	Airplane	Basketball	Wasp	Kiwi	Drums
Monkey	Tram	Running	Spider	Grape	Trumpet
Lion	Boat	Table tennis	Beetle	Pineapple	Saxophone
Pig	Moped	Gymnastics	Ladybird	Cherry	Pipe
Mouse	Truck	Judo	Butterfly	Lemon	Cello
Giraffe	Scooter	Golf	Cockroach	Mango	Clarinet
Sheep	Motor	Rugby	Grasshopper	Lychee	Harp

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